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E-BIOMED: A PROPOSAL FOR ELECTRONIC PUBLICATION IN THE BIOMEDICAL SCIENCES

Prologue

It is now widely recognized that electronic communication has the capacity to make dramatic changes in the way information is exchanged among scientists, including biomedical scientists. Indeed, many such changes have already happened and are continuing to happen at a rapid rate. Over the past decade, steeply increasing numbers of scientists on all continents have abandoned traditional mail and FAXes in favor of electronic mail. Most log on to GenBank and many other data repositories on a nearly daily basis. The titles and abstracts of papers published in most scientific journals are available "on line" from the date of publication and sometimes even before; some full texts can be accessed electronically and downloaded, with or without subscription fees; and convenient sites, such as NIH's PubMed (http://www.ncbi.nlm.nih.gov/PubMed/), provide powerful engines for searching the literature. In at least one field, physics, preprints are made available electronically to interested readers, through a server called "e-print"(http://www.xxx.lanl.gov). In other fields, including biology, laboratories frequently maintain World Wide Web pages that offer their colleagues deeper views of the data that support published findings, describe methods in detail, illustrate the most recent talks given by lab leaders, and serve as important sources of specialized information and links to other Web sites and citations.

Despite these welcome and transforming changes, we believe that the full potential of electronic transmission has yet to be realized, because the scientific community has made only sparing use thus far of the Internet as a means to publish scientific work and to distribute it widely and without significant barriers to access. Several observers have written informative and even visionary essays on this topic (see, for example, articles by Walker [http://www.amsci.org/amssci/article/98articles/walker.html] and Harnad [http://www.princeton.edu/~harnad/nature.html] and references cited therein). In this essay, we advance a proposal for electronic publication of results in the biomedical sciences. We do this with the conviction that such means of publication can accelerate the dissemination of information, enrich the reading experience, deepen discussions among scientists, reduce frustrations with traditional mechanisms for publication, and save large sums of public and private money.

Before describing and defending our proposal, it is important to acknowledge the strengths of the currently used system for published scientific work, because it has, in general, served the scientific community well for over 300 years. Printed journals, particularly the few hundred leading representatives, do more than just transmit results to our community. They subject the reports to peer review and editing, a process that reassures busy readers that papers have been carefully scrutinized and affords the authors an opportunity to improve their work based on the (generally anonymous) advice of their colleagues. The perceived hierarchy of the journals is useful for conferring status and grounds for career advancement on the authors of papers accepted by the most prestigious journals, and it provides a useful guide to readers besieged by the proliferation of published work. Moreover, current journals often present their reports in attractive formats, bound between

colorful covers and accompanied by research commentaries, reviews, and various kinds of news, advertisements, and technical advice. In addition to being conducive to concentrated study, pleasurable reading, and skimming, journals are usually convenient to carry, fitting nicely into briefcases and adapting to activities like riding the subway or sitting on the beach. Finally, their very existence as "periodicals" implies a rhythm that can (in the best of circumstances) stimulate anticipation of forthcoming issues and their contents.

No proposal to change the way in which the publication of scientific results occurs should ignore these and other virtues of the current system. But we believe that current practices also have many liabilities and that these can be addressed by an evolutionary approach that need not threaten most of the benefits attributable to the print-based publication system that is now in place. More importantly, electronic publication can offer several remarkable benefits that could never be achieved through ~~a system that depends principally on print-based journals~~. Many of these benefits depend on low-cost, barrier-free access by scientists to all of findings of their fellow scientists in a conveniently displayed format.

A proposal for E-biomed

In the plan presented here, the NIH would facilitate a community-based effort to establish an electronic publishing site, called "E-biomed." It is important to emphasize at the outset that in no sense would the NIH operate as the owner or rule-maker for this enterprise; we are proposing this plan in an effort to accelerate much-needed public discussion of electronic publication and to offer financial, technical, and administrative assistance to help initiate a program ~~for which there is~~ broad support throughout the biomedical research community, in the United States and abroad.

In the plan we envision, E-biomed would transmit reports in the many fields normally construed as constituting biomedical research, including clinical research, cell and molecular biology, medically-related behavioral research, biogineering, and other disciplines allied with biology and medicine. The essential feature of the plan is simplified, cost-free access by potential readers to E-biomed's entire repetoire in a manner that permits each reader to pursue his or her interests in the most productive possible fashion. We have attempted to endow the plan with the flexibility necessary for evolution as patterns of use become established and as new opportunities for enriching the system are proposed. And we suggest a mechanism for governance (the E-biomed Governing Board) that involves all of the parties concerned---the scientific community (readers and authors), editors, computer specialists, and funding agencies.

All scientific reports in E-biomed would be stored in the "E-biomed repository," accessed through a single central server, and deposited and displayed using either of two mechanisms, as described in more detail in the succeeding sections. (i) Many (or even most) reports would be listed as contents of electronic journals after favorable review by editorial boards. These boards could be identical to those that represent current print journals or they might be composed of members of a scientific society or other groups approved by the E-biomed Governing Board. (ii) Another large set of reports would be deposited in a general file in the E-biomed repository by a less formal process that would include endorsement by at least two individuals.

(i) Submission to E-biomed through editorial boards

The first of the two mechanisms that authors would use to enter new scientific reports into the E-biomed database is closely aligned with current practice and retains scientific review as a major component. Authors would submit reports electronically to the central server,

requesting review by the editorial board of an indicated journal in an appropriate field. If, after review, the report is accepted for publication in either its original or a revised form, it would be deposited immediately in E-biomed, and its title and list of authors would appear for a fixed period (a week, two weeks, or a month) on the current table of contents for that journal. Later, it would continue to be accessible through the E-biomed search engine or through the journal's home page, annotated with the dates of submission and acceptance.

If the editorial board judges the report unsuitable for deposition in E-biomed, the authors could resubmit the report for review by another board, defer further ~~consideration of~~ dissemination ~~of~~ the findings, or contemplate submission to E-biomed through the alternative mechanism described in part (ii).

Electronic publishing provides an opportunity to offer a third outcome to the review process, one that provides a novel solution to one of the most commonly encountered problems in current editorial practice. If a submitted report is deemed by the editorial board to be appropriate for viewing by the scientific community, but judged not to meet the standards set by the journal for inclusion among its limited number of prime listings, the editorial board could still accommodate the report by chosing to maintain one or more additional listings. These additional listings might be grouped by specialty or simply designated as a larger, less exclusive version of the primary listing. Authors of reports that meet the criteria set for these listings---which, while less prestigious, still denote review and endorsement by the journal's editorial board --- could then elect immediate deposition in the E-biomed repository through this channel. Alternatively, they could choose to resubmit to another journal, as in current practice, hoping for inclusion among reports considered to have higher status.

(ii) Submission to E-biomed through the general repository

Authors would also have the option of entering scientific reports directly into the E-biomed repository, without endorsement by an editorial board. At least initially, this option might be considered ~~for disseminating~~ negative findings, methods, or archival information. Before formal entry into the data base, each report would ~~have~~ to be approved by two individuals with appropriate credentials. These credentials, to be established by the E-biomed Governing Board, should be broad enough to include thousands of scientists but stringent enough to provide protection of the database from extraneous, false, or outrageous material. (Such credentials might be membership on any approved editorial board or receipt of a research grant from a reputable funding source.) Criteria for approval of reports must be sufficiently firm to guard against gross abuse of the E-biomed repository, but sufficiently flexible could be free to solicit an endorsement from a specific editorial board as a means to provide greater prestige to a paper. Use of the general repository might be limited initially because of the perception that it confers low visibility and status on a report. With experience, however, it may become a much more common practice because of the speed of publication, the power of search engines to identify entries, and the flexible instruments (appended commentaries, citation counts, and accession data) for enhancing status over time.

Inherent and prospective benefits of E-biomed

We contend that establishment of the E-biomed system would deliver several powerful benefits to the scientific community, with very little risk and with the opportunity for supplementing the system with further improvements in the near future. In this section, we describe some of the benefits that we envision and contrast them with the deficiencies of current publication methods.

More rapid dissemination of scientific information

One of the least appealing features of the current methods for scientific publication is the lengthy pause that occurs between completion of a research report and its appearance on the printed page. Some of this time is consumed by the review process, especially when authors are obliged to submit their report sequentially to multiple journals before finding a suitable "home" for it. Moreover, there continues to be significant doubt about whether reports are often improved to an extent commensurate with the duration of this process, especially when it is protracted. Then additional time, generally a few months, is devoted to the journal production phase, once a report has been accepted for publication. Although increasing numbers of journals are going "on line" on the day of publication and rare journals make their reports available electronically at the time of acceptance, electronic distribution of material in print journals is complicated by subscription fees and other "toll gates" and is often delayed for months beyond printing time.

Our proposal would markedly speed up the process at each phase. This would be especially so for reports that are entered directly into the E-biomed repository after being "approved" without traditional editorial review. But even those reports reviewed and listed by editorial boards would be available earlier to the reading public because they would all be posted at the time of acceptance, eliminating the lag time now ascribable to publication on paper. Moreover, many fewer reports would be sequentially reviewed by more than one editorial board in order to find a publishing outlet; this too would significantly decrease the time that elapses between the drafting of a report and its transmission to interested readers. It is also likely that more uniform electronic publishing will speed the review period, because electronic methods will probably be more generally employed to submit, transfer, review, alter, and edit the reports. In fact, those editorial boards that develop the most efficient and most accessible review processes will compete ~~more~~ effectively for the ~~outstanding re~~ports.

Reduced expenses

One of the most unfortunate features of the current situation in biomedical publishing is its enormous costs, levied on the users in a variety of ways: subscriptions, page charges, and time and labor. Subscription fees for many of the journals, often for both print and electronic versions, are the most obvious costs, especially those charged to libraries and other institutions. (Such expenses have recently been the subject of a much publicised scholarly report---accessible at http://jan.mannlib.cornell.edu/jps/jps.htm---and have been held responsible for the decline in publication of academic monographs [see "The New Age of the Book" by Robert Darnham in The New York Review of Books, pp.5-7, March 18, 1999].)

While our proposal cannot eliminate all of the costs associated with scientific publishing, ~~and would not---and is not intended to---put an end to all subscription fees~~, movement to an electronic format is likely to reduce "production" costs by at least 70 percent, ~~and [illegible]~~ Furthermore, E-biomed would likely have a significant effect on costs by reducing or eliminating the profits currently earned some publishers. These important changes would offer savings to individuals (who are often trainees living on limited stipends), to laboratories (which would rather spend their funds on reagents, instruments, or scientific meetings), to institutions (which often complain about the fiscal pressures placed on them by technical activities), and to funding agencies (which would, of course, prefer to use their monies to support experimental work and training).

Improved format for publication of modern biology

More general use of electronic publishing through E-biomed would expedite the wider use of presentation ~~methods~~ that are now slowly gaining acceptance at web sites and supplements to print publications. With the dramatic expansion of space, it will be possible to present much larger data sets (including detailed photographs and movies), provide more extensive analysis, and describe methods in the precise detail necessary to recapitulate the experiments. Moreover, electronic formats allow layered viewing at increasingly greater levels of detail, so that readers can first get a concise message and then pursue information in proportion to need and interest. Publication in E-biomed would also offer many of the other advantages that are now obvious from the transfer of journal articles into electronically accessible forms: hyperlinks to relevant literature, databases, and websites; registration for future retrieval of related papers; and other conveniences.

Other possibilities

The new system we are advocating here may seem like a radical change from some perspectives, but it also offers the prospect of evolution to still more changes. Among these is the possibility of engaging electively in a more open reviewing process---one in which critiques of the scientific reports are accessible and possibly signed. This development, if widely accepted, could offer many benefits: more responsible reviews, an instructive and ongoing public conversation about published work, and career rewards for useful commentaries about the work done by others. The E-biomed repository might also serve as a communal site for posting notices of meetings and job opportunities; for providing synopses---or even full texts with illustrations---of talks presented at scientific symposia; and for engaging in world-wide discussions of a variety of scientific and political issues. Furthermore, electronic publication permits the amendment of reports; updated versions would be announced and clearly denoted as such, while the original version is preserved as a 1.0 file for the historical record and downloaded for safekeeping ~~in repositories.~~

One further, less tangeable benefit might also occur---a heightened sense of community among biomedical scientists as a natural outcome of shared use of E-biomed. This might be conducive to the adoption of uniform standards for sharing data and providing access to research tools described in E-biomed.

How do we get started?

Profound changes in a time-honored system that is central to biomedical research should be undertaken with caution, no matter how great the possible benefits. For that reason, we offer this proposal---and ~~hope~~ to publish it in a widely read journal---with the ~~intention~~ of stimulating a much broader discussion of electronic publishing than has occurred thus far. We hope to engage the editorial boards and publishers of existing journals, members of scientific societies, and the entire scientific community in an international debate that could last for several months.

A number of questions need to be addressed:

• Does the plan make sense? Is it likely to achieve the benefits we ascribe to it? Are there other (better) ways to achieve them?

• How should E-biomed be financed and managed? The NIH is prepared to provide funds and expertise to initiate the project, but in the long run a self-sustaining organization should be formed. Should it be supported by funding agencies? By "submission charges" ~~to~~ paid by authors? By other mechanisms?

• What should be the composition of the E-biomed Governing Board? . The Board, in conjunction with the editorial boards, would be responsible for developing rules of operation, producing an annual budget projection, negotiating with groups asking to establish editorial boards, resolving disputes, and dealing with other ancillary matters. But how much authority should the Governing Board have over the functions of editorial boards that participate in E-biomed?

If a significant component of the biomedical research community can reach agreement on these issues, we would publicize an appropriately modified proposal, assemble the Governing Board, and assist in the development and initial operation of the E-biomed site, perhaps as soon as a year from now.

Consequences and concerns

Despite the many benefits that might derive from the proposed E-biomed system, there will be legitimate sources of concern and likely significant opposition. In this final section, we consider some of the most obvious questions.

How would life change for the average reader of the scientific literature?

Most scientists are likely to be concerned about three questions when they are obliged to contemplate fundamental changes in their reading habits: (i) "How will the changes affect my ability to find all of the papers relevant to my specialized research area?" (ii) "How will I be guided through the mass of current literature to the few reports of special merit in fields related to my own?" (iii) "How will I be enabled to browse usefully and enjoyably among a broad range of recent reports to seek those that unexpectedly benefit my work or widen my perspective?"

Answers to the first two questions are embedded in the organization that we envision for the E-biomed database. Because all reports filed there would be surveyed by a single search engine, it will be easy to insure that all new reports addressing topics of interest to any single reader or laboratory are highlighted on a routine (even a daily) basis. The potential significance of each of these reports would likely be apparent then, as now, from its title, its authors, and the quality of the editorial board (if any) that approved it. Readers could also be alerted each time that the electronic journals of greatest importance to them post new selections. Browsing could be done electronically by going to tables of contents for selected editorial boards. But it is likely that browsing would also be conducted with printed materials in more comfortable settings, perhaps by using new magazines created as guides to segments of E-biomed or by using altered versions of existing journals (see below).

These notions underwrite a central and very attractive feature of E-biomed---the ability of each user to create his or her own "virtual journal" by downloading the reports that each person would like to read during the current week. At present, virtually all scientists work surrounded by towering piles and sagging shelves of print journals crammed with papers that are largely irrelevant to their line of thought that week. E-biomed could make it possible for every individual to scan the entire biomedical literature regularly, yet to focus in detail on just those several reports that are of greatest interest.

What would happen to existing journals?

We anticipate several different answers to this question. Some of the most popular and prestigious journals might not change at all, at least in foreseeable future; many of these already distribute---or are planning to distribute---the full texts of their articles in electronic formats, albeit without the unrestricted public access that we advocate for E-biomed. Other very popular journals might continue print publication, but in a somewhat altered form. For example, journals that contain appreciable numbers of news articles, research summaries, and reviews might expand those departments and publish fewer or no scientific reports. Or these high circulation journals might open a site for their scientific contributions within E-biomed and restrict their print versions to the other types of material. Conversely, some print journals might be created to serve as guides to general or specialized reading in the E-biomed database. These new journals might feature readable summaries of outstanding articles, perhaps accompanied by one or two figures, allowing individual readers to scan selected new entries for items that might warrant a visit to the full electronic text, downloading, and more careful reading.

Many, perhaps even most, of the thousands of existing journals in the biomedical sciences might abandon their print versions over the next few years, depending upon the success of the E-biomed project. A significant number would be expected to reestablish their editorial boards at the E-biomed site, thereby becoming fully electronic journals that operate as described in an earlier section. Other journals---especially those lack the support of a scientific or professional society---might disappear altogether. The papers that presently appear in such journals would then find their way into the E-biomed repository instead. This change would, of course, save enormous amounts of time and money, without any apparent sacrifice of benefits.

Some of these changes may be strongly resisted by commercial publishers who currently generate remarkable profits from their scientific journals and even by professional organizations that depend on income from journal subscriptions to sustain other commendable activities. In our view, scientific publishing should be strongly influenced by those who use the system as authors, reviewers, and readers---the people forming the rank-and-file of those professional organizations.

How do we guarantee equity in the new system?

Although the current system of scientific publishing can be criticized for lapses of fairness, it has, in general, served us well. Thus any new system must be developed with concern for the ambitions of trainees, little-known scientists, or scientists at less prestigious institutions or foreign sites. Clearly, electronic communication has enormous advantages for people in all of these categories, because it is a democratizing force that makes distance and wealth nearly irrelevant. However, it is important to insure that opportunities to enter reports into E-biomed are just as rich as the opportunities to access the reports filed by others. The editorial boards and the Board of Governors will need to give careful attention to this issue; for instance, it will be imperative to provide a means for any author, however remotely located or poorly known, to have access to two "members" of the system to validate reports submitted to the general repository.

Summary

The advent of the electronic age and the rise of the Internet offer an unprecedented opportunity to change scientific publishing in ways that could improve on virtually all aspects of the current system. The NIH has addressed this opportunity by proposing a new system, E-biomed, that has many advantages over the existing means of disseminating research findings: open access, greater speed, reduced cost, and enhanced depth of presentation. We now welcome constructive comments from the scientific community, with the intention of helping to put a suitably revised plan into operation in the near future.

Note: This draft was written by Harold Varmus, with active assistance from David Lipman and Pat Brown, and advice from several others. Comments will be gratefully received by email (varmus@nih.gov, pbrown@cmgm.stanford.edu, lipman@ncbi.nlm.nih.gov)